

REMARKS

Summary of the Amendment

Upon entry of the above amendment, the specification and claims 14 - 16 and 32 - 37 will have been amended. Accordingly, claims 14 - 37 will remain pending.

Summary of the Official Action

In the instant Office Action, the Examiner has objected to the specification and claims for informalities and has rejected claim 24 based upon a formal matter. Further, claims 14 - 37 have been rejected over the art of record. By the present amendment and remarks, Applicants submit that the objections and rejections have been overcome, and respectfully request reconsideration of the outstanding Office Action and allowance of the present application.

Acknowledgment of Interview with Examiners Kibler and Au

Applicants gratefully acknowledge the courtesy extended to their representative by Examiners Kibler and Au in conducting a personal interview on February 25, 2003. In the interview, the distinguishing features of the present invention were discussed, and it was agreed that independent claims 14 and 32 would be amended to recite the linear movement of the beam tube and detector and that the test element is fixed stationarily throughout inspection of the test piece.

Further, Applicants clarified that the instant invention is intended for inspecting all soldering joints on the test piece, and that this is what is meant by the objected "fully

automated 100% X-ray inspection” in claim 24.

Traversal of Objection to Specification

Applicants traverse the objection to the specification for informalities. While having amended the first full paragraph on page 10 in the manner suggested by the Examiner, Applicants submit that the suggested change on page 5 would be grammatically incorrect.

Accordingly, Applicants request that the Examiner reconsider and withdraw the objection to the specification, and indicate that the specification is in conformance with the requisite rules.

Objection to Claims is Moot

By the present amendment, claim 16 has been amended in the manner suggested by the Examiner in order to clarify the claim. Thus, Applicants submit that the objection to the claims is moot.

Accordingly, Applicants request that the Examiner reconsider and withdraw the objection to claims.

Traversal of Rejection Under 35 U.S.C. § 112, First Paragraph

Applicants traverse the formal rejection of claim 24 under 35 U.S.C. § 112, first paragraph, as being indefinite.

As discussed in the above-noted interview, Applicants clarified that the term objected “fully automated 100% X-ray inspection” refers to an automated process in which all of the soldered joints are inspected automatically. Moreover, Applicants note that page 9 of the

specification, between lines 20 and 22, clearly and unambiguously discloses that “Figure 1 is an example of a completely automated 100% X-ray inspection of soldered joints on printed circuit boards,” such that there is sufficient enabling disclosure for the term recited in claim 24.

Further, Applicants submit that one ordinarily skilled in the art reviewing the application and claims would be able to readily ascertain the scope of the invention recited in claim 24, so as to make and use the invention in accordance with the subject matter recited in claim 24. Accordingly, Applicants request that the Examiner reconsider and withdraw the formal rejection of claim 24 under 35 U.S.C. § 112, first paragraph, and indicate that the instant application and claims are fully in compliance with the requirements of the statute.

Traversal of Rejection Under 35 U.S.C. § 102(e)

Applicants traverse the rejection of claims 14 - 20, 22, 23, 27- 29, 32, and 33 - 35 under 35 U.S.C. § 102(e) as being anticipated by ADAMS et al. (U.S. Patent No. 5,561,696) [hereinafter “ADAMS”]. The Examiner asserts that ADAMS shows an apparatus for inspecting a test object with a movably arranged X-ray beam tube and detector 30 and a stationary object 10, and that the X-ray beam tube and the detector both have a small field of view in relation to the horizontal extent of the are of the test object to be inspected. Applicants traverse the Examiner’s assertions.

By way of review, Applicants note that the instant invention prevents much of the unintended damage to soldering joints that occurs in the heretofore known inspection

devices. In particular, in these known devices, the X-ray beam source and detector are fixedly mounted within an inspection chamber and the test piece is movably mounted within the inspection chamber. In this manner, the test piece is moved in such a manner that various soldering joints of the test piece are positioned within the X-ray beam. However, Applicants have found that the stopping and starting of the test piece within the inspection chamber loosens and/or breaks the soldering joints, and, if such joints are loosened and/or broken after being inspected, the defects will not be found, and a defective test piece will be deemed acceptable.

To address this deficiency of the prior art, Applicants have provided a device and process in which the test piece is fixedly mounted in a stationary position throughout the inspection process, such that the inadvertent loosening and/or breaking of soldering joints is substantially eliminated. However, because the test piece is fixedly mounted, the X-ray beam source and detector are mounted for linear movement in order to inspect each soldering joint located on the test piece. As discussed in the specification between page 5, line 14 and page 6, line 4, while movement of the X-ray beam source and detector is generally considered problematic, the present invention addresses and solves such problems by using an X-ray beam tube without a vacuum pump or cooling and a device for horizontally moving the X-ray beam tube and detector to ensure that these components are moved with great accuracy and at high speeds despite their large mass.

Accordingly, Applicants independent claim 14 recites, *inter alia*, the at least one test object is *fixed in a stationary position throughout the inspection*, and said X-ray beam tube and said detector are *linearly moveably arranged* within parallel X-Y planes for inspecting an entire area of the at least one test object. Further, Applicants independent claim 32 recites, *inter alia*, *fixedly mounting* the at least one test object *in a stationary position throughout the inspecting of an entire area* of the at least one object, and *linearly moving* the X-ray beam tube and the detector within parallel X-Y planes, thereby inspecting the entire area of the at least one test object. Applicants submit that ADAMS fails to disclose at least the above-noted features.

Applicants note that, while it does not provide any specific disclosure as to how the source/detector arrangement is achieved, Figure 1 of ADAMS illustrates a source and a detector rotating about a common axis in parallel planes while inspecting a test piece. In this arrangement, while the beam is rotated about axis 40, the beam is focussed on a single point on the test piece. In a further embodiment, Figure 46a of ADAMS illustrates a stationary source mounted for rotation, but, like Figure 1, the produced beam is focussed on a single point on the test piece.

Thus, while ADAMS shows some movement of the source, ADAMS express discloses that the beam produced by the source should be focussed on a single point on the test piece, which is supported by a fixture attached to a positioning table for moving the test

piece in the X, Y, and Z directions. In this manner, the test piece of ADAMS is moved so that the desired test points are moved into the beam. As discussed above, this movement of the test piece is what the instant invention seeks to avoid, since such movement can adversely affect the soldering joints by loosening or breaking them.

Therefore, Applicants submit that, in contrast to the feature of instant invention, ADAMS fails to disclose a test piece that is *fixed in a stationary position throughout the inspection*, and fails to disclose an X-ray beam tube and detector that are *linearly moveably arranged within parallel X-Y planes for inspecting an entire area of the at least one test object*, as recited in at least independent claim 14. Further, Applicants note that ADAMS likewise fails to disclose *fixedly mounting the at least one test object in a stationary position throughout the inspecting of an entire area of the at least one object, linearly moving the X-ray beam tube and the detector within parallel X-Y planes, to inspect the entire area of the at least one test object*, as recited in at least independent claim 32.

Because ADAMS fails to disclose the above-noted features, Applicants submit that this document fails to show each recited feature of the invention. Thus, Applicants submit that ADAMS fails to provide an adequate evidentiary basis to support a rejection of anticipation under 35 U.S.C. §102(e), and that the rejection is improper and should be withdrawn.

Further, Applicants submit that claims 15 - 20, 22, 23, 27 - 29, and 32 - 35 are

allowable at least for the reason that these claims depend from allowable base claims and because these claims recite additional features that further define the present invention. In particular, Applicants submit that ADAMS fails to anticipate, *inter alia*, a carrier adapted to be fixedly mounted throughout the inspection of the at least one test object, wherein said carrier is coupled to the at least one test object during the inspection, as recited in claim 15; a computing device being coupled to said detector, as recited in claim 16; an analysis unit being connected to said computing device, as recited in claim 17; said X-ray beam tube comprises a microfocus tube with a focal spot diameter of 10 to 40 μm , as recited in claim 18; said detector comprises a CCD chip arranged on a taper, as recited in claim 19; said X-ray beam tube and said detector are adapted for two-dimensional inspection of the test object, as recited in claim 20; the at least one test object comprises at least one of a printed circuit board and a loaded printed board assembly, as recited in claim 22; said device is adapted for X-ray inspection of soldered joints on at least one of printed circuit boards and loaded printed board assemblies, as recited in claim 23; said X-ray beam tube and said detector are adapted to move parallel to each other, as recited in claim 27; said X-ray beam tube and said detector are adapted to move together in a same direction, as recited in claim 28; said X-ray beam tube and said detector are adapted to move in a same direction, as recited in claim 29; linearly moving the X-ray beam tube and the detector parallel to each other, as recited in claim 33; linearly moving the X-ray beam tube and the detector together in a same direction,

as recited in claim 34; and linearly moving the X-ray beam tube and the detector a same direction, as recited in claim 35.

Accordingly, Applicants request that the Examiner reconsider and withdraw the rejection of claims 14 - 20, 22, 23, 27 - 29, and 32 - 35 under 35 U.S.C. §102(e) and indicate that these claims are allowable.

Traversal of Rejection Under 35 U.S.C. § 103(a)

1. Over Adams in view of Parker

Applicants traverse the rejection of claims 21, 24, 31, and 37 under 35 U.S.C. § 103(a) as being unpatentable over ADAMS in view of PARKER (U.S. Patent No. 5,461,653). The Examiner asserts that, while ADAMS only discloses an X-ray tube and detector adapted to two-dimensional inspection, PARKER shows a device for three-dimensional inspection. Applicants traverse the Examiner's assertions.

While it appears, contrary to the Examiner's assertions, that ADAMS does inspect in three dimensions, Applicants note that neither ADAMS nor PARKER provide any teaching or suggestion of fixedly mounting the test piece in a stationary position throughout the inspection of the test piece and/or of an X-ray beam source and detector linearly mounted for movement within parallel X-Y planes, as recited in at least independent claims 14 and 32.

In particular, both applied documents move the test piece throughout the inspection in order to position the joint under test in a desired position. Moreover, neither applied documents provides any teaching or suggestion for linearly moving the beam source and

detector in parallel planes.

Because neither document teaches or suggests the above-noted features, Applicants submit that no proper combination of these documents can render unpatentable the combination of features recited in at least independent claims 14 and 32.

Moreover, Applicants note that, as neither applied document has identified the problem of loosening and/or breaking soldering joints due to the moving of the test piece throughout the inspection process, the art of record cannot even arguably suggest a solution to this problem. Therefore, Applicants submit that the applied art likewise fails to render the instant invention obvious.

Further, Applicants submit that claims 21, 24, 31, and 37 are allowable at least for the reason that these claims depend from allowable base claims and because these claims recite additional features that further define the present invention. In particular, Applicants submit that no proper combination of ADAMS and PARKER teaches or suggests, *inter alia*, said X-ray beam tube and said detector are adapted for three-dimensional inspection of the at least one test object, as recited in claim 21; said device is adapted for fully automated 100% X-ray inspection of soldered joints on at least one of printed circuit boards and loaded printed board assemblies, as recited in claim 24; said X-ray beam tube and said detector are adapted to move parallel to the at least one test object, as recited in claim 31; and linearly moving the X-ray beam tube and the detector parallel to the at least one test object, as recited in claim

37.

Accordingly, Applicants request that the Examiner reconsider and withdraw the rejection of claims 21, 24, 31, and 37 under 35 U.S.C. §103(a) and indicate that these claims are allowable.

2. Over Adams in view of Armistead

Applicants traverse the rejection of claim 25 under 35 U.S.C. § 103(a) as being unpatentable over ADAMS in view of ARMISTEAD (U.S. Patent No. 4,852,131). The Examiner asserts that ARMISTEAD shows the use of learned characteristic vectors, and that it would have been obvious to modify ADAMS to include such a feature. Applicants traverse the Examiner's assertions.

In contrast to the instant invention, Applicants note that ARMISTEAD discloses a scanning beam through which a test piece is moved. Moreover, Applicants note that the beam source and detector are fixedly mounted. Accordingly, Applicants submit that ARMISTEAD fails to teach or suggest the subject matter noted above as deficient in ADAMS.

Further, as neither ADAMS nor ARMISTEAD provide any teaching or suggestion of fixedly mounting the test piece in a stationary position throughout the inspection of the test piece and/or of an X-ray beam source and detector linearly mounted for movement within parallel X-Y planes, Applicants submit that no proper combination of these documents can

arguable teach or suggest the combination of features recited in at least independent claim 14.

Moreover, ARMISTEAD also fails to identify the problem addressed by the instant invention, i.e., loosening and/or breaking soldering joints due to the moving of the test piece throughout the inspection process, the applied art of record cannot even arguably suggest a solution to this problem. Therefore, Applicants submit that the applied art likewise fails to render the instant invention obvious.

Further, Applicants submit that claim 25 is allowable at least for the reason that it depends from an allowable base claim and because it recites additional features that further define the present invention. In particular, Applicants submit that no proper combination of ADAMS and ARMISTEAD teaches or suggests, *inter alia*, an analysis unit coupled to said detector, said analysis unit including a learning mode, so that, in said learning mode, a set of testing algorithms is transmitted to the analysis unit, and the algorithms are used to generate a characteristic vector for an individual soldered joint that is optimized to statistically represent a defect-free soldered joint, such that the characteristic vector is optimized by analyzing vectors of a same soldered joint on other at least one of printed circuit boards and loaded printed board assemblies, as recited in claim 25.

Accordingly, Applicants request that the Examiner reconsider and withdraw the rejection of claim 25 under 35 U.S.C. §103(a) and indicate that this claim is allowable.

3. Over Adams in view of Armistead and further in view of Rooks

Applicants traverse the rejection of claim 26 under 35 U.S.C. § 103(a) as being unpatentable over ADAMS in view of ARMISTEAD and ROOKS (U.S. Patent No. 5,719,952). The Examiner asserts that ROOKS shows the use of a frame or pad image buffer, and that it would have been obvious to modify ADAMS and ARMISTEAD to include such a feature. Applicants traverse the Examiner's assertions.

Applicants note that ROOKS discloses a fixedly positioned rotating beam source and a fixedly positioned rotating detector in which a test piece is moved through a focal plane between these fixed rotating elements. Thus, Applicants submit that ROOKS fails to teach or suggest the subject matter noted above as deficient in the asserted combination of ADAMS and ARMISTEAD, such that no proper combination of the applied documents can render the instant invention unpatentable.

Further, Applicants note that as none of the applied documents of record identify the problem that Applicants have solved by the instant invention, the applied art of record cannot even arguably suggest Applicants solution or render the instant invention obvious.

Further, Applicants submit that claim 26 is allowable at least for the reason that it depends from an allowable base claim and because it recites additional features that further define the present invention. In particular, Applicants submit that no proper combination of ADAMS, ARMISTEAD, and ROOKS teaches or suggests, *inter alia*, said analysis unit

further including a testing mode, such that, in said testing mode, a pad image buffer, the set of testing algorithms, and the learned characteristic vectors with tolerances are transmitted to said analysis unit, and, in order to test a soldered joint, a correlation between the learned characteristic vectors with tolerances and the soldered joint under test is determined, as recited in claim 26.

Accordingly, Applicants request that the Examiner reconsider and withdraw the rejection of claim 26 under 35 U.S.C. §103(a) and indicate that this claim is allowable.

4. Over Adams in view of Ichinose

Applicants traverse the rejection of claims 30 and 36 under 35 U.S.C. § 103(a) as being unpatentable over ADAMS in view of ICHINOSE et al. (U.S. Patent No. 5,463,667) [hereinafter “ICHINOSE”]. The Examiner asserts that ICHINOSE teaches that it is known to move the X-ray beam tube and detector (*see* Figure 5), and that it would have been obvious to modify ADAMS accordingly. Applicants traverse the Examiner’s assertion.

Applicants note that, while ICHINOSE discloses rotational movement that of a beam source and detectors around and axis, there is no teaching or suggestion of linear moved. Further, Applicants note that, as the arrangement of the beam and detectors enables a “scanning” of the joints under test, but that the specific joints under test must be moved into the scanning position, ICHINOSE fails to teach or suggest fixedly mounting the test piece in a stationary position throughout inspection, as recited in at least independent claims 14 and

32.

Further, Applicants note that, like the other applied art of record, ICHINOSE fails to identify the problem solved by the instant invention. Thus, Applicants submit that the applied art of record cannot even arguably render unpatentable the instant invention.

Further, Applicants submit that claims 30 and 36 are allowable at least for the reason that these claims depend from allowable base claims and because these claims recite additional features that further define the present invention. In particular, Applicants submit that no proper combination of ADAMS and ICHINOSE teaches or suggests, *inter alia*, said X-ray beam tube and said detector are adapted to move in opposite directions, as recited in claim 30; and linearly moving the X-ray beam tube and the detector in opposite directions, as recited in claim 36.

Accordingly, Applicants request that the Examiner reconsider and withdraw the rejection of claims 30 and 36 under 35 U.S.C. §103(a) and indicate that these claims are allowable.

Application is Allowable

Thus, Applicants respectfully submit that each and every pending claim of the present invention meets the requirements for patentability under 35 U.S.C. §§ 102 and 103, and respectfully request the Examiner to indicate allowance of each and every pending claim of the present invention.

Authorization to Charge Deposit Account

If for any reason a check including the amount for any necessary fees is not associated with this file, the Commissioner is authorized to charge to Deposit Account No. 19 - 0089 the amounts identified herein for the missing check, as well as any necessary fees not explicitly identified, including any extensions of time fees required to place the application in condition for allowance by Examiner's Amendment, in order to maintain pendency of this application.

CONCLUSION

In view of the foregoing, it is submitted that none of the references of record, either taken alone or in any proper combination thereof, anticipate or render obvious the Applicants' invention, as recited in each of claims 14 - 37. The claims have been amended to eliminate any arguable basis for rejection under 35 U.S.C. § 112. In addition, the applied references of record have been discussed and distinguished, while significant claimed features of the present invention have been pointed out.

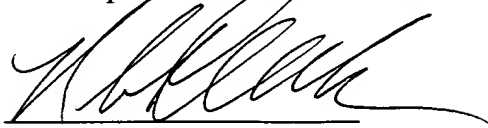
Further, any amendments to the claims which have been made in this response and which have not been specifically noted to overcome a rejection based upon the prior art, should be considered to have been made for a purpose unrelated to patentability, and no estoppel should be deemed to attach thereto.

Accordingly, reconsideration of the outstanding Office Action and allowance of the present application and all the claims therein are respectfully requested and now believed to

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be appropriate.

Respectfully submitted,
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APPENDIX

Marked-Up Copies of the Amended Paragraphs:

Please replace the first full paragraph on page 10 (between lines 5 and 10) with the following amended paragraph:

At the beginning of the soldered joint examination, the loading data of the board assembly [are] is retrieved. The loading data (CAD data) [define] defines which component is placed at which position and at what angle of rotation. On the basis of this information and taking into consideration the object resolution, it is possible for each recorded X-ray image to determine precisely where a soldered joint of a component is shown in the X-ray image.

Marked-Up Copies of the Amended Claims:

14. (Amended) A device for inspecting at least one test object comprising:
an X-ray beam tube having a small field of view in relation to a horizontal extent of an area of the at least one test object to be inspected; and
a detector having a small field of view in relation to the horizontal extent of the area of the at least one test object to be inspected,
wherein the at least one test object is fixed in a stationary position throughout [during] the inspection, and said X-ray beam tube and said detector are linearly moveably arranged within parallel [an] X-Y [plane] planes for inspecting an entire area of the at least one test object.

15. (Amended) The device in accordance with claim 14, further comprising a carrier adapted to be fixedly mounted [during] throughout the inspection of the at least one test object,

wherein said carrier is coupled to the at least one test object during the inspection.

16. (Amended) The device in accordance with claim 14, further comprising a computing device being coupled [connected] to said detector.

32. (Amended) A process of inspecting at least one test object with an apparatus that includes an X-ray beam tube having a small field of view in relation to a horizontal extent of an area of the test objects to be inspected, and a detector having a small field of view in relation to the horizontal extent of the area of the test objects to be inspected, the process comprising:

fixedly mounting the at least one test object in a stationary position throughout the inspecting of an entire area of the at least one object; and

linearly moving the X-ray beam tube and the detector within parallel [an] X-Y [plane] planes, thereby inspecting [an] the entire area of the at least one test object.

33. (Amended) The process in accordance with claim 32, further comprising linearly moving the X-ray beam tube and the detector parallel to each other.

34. (Amended) The process in accordance with claim 33, further comprising linearly moving the X-ray beam tube and the detector together in a same direction.

35. (Amended) The process in accordance with claim 33, further comprising linearly moving the X-ray beam tube and the detector a same direction.

36. (Amended) The process in accordance with claim 33, further comprising linearly moving the X-ray beam tube and the detector in opposite directions.

37. (Amended) The process in accordance with claim 32, further comprising linearly moving the X-ray beam tube and the detector parallel to the at least one test object.